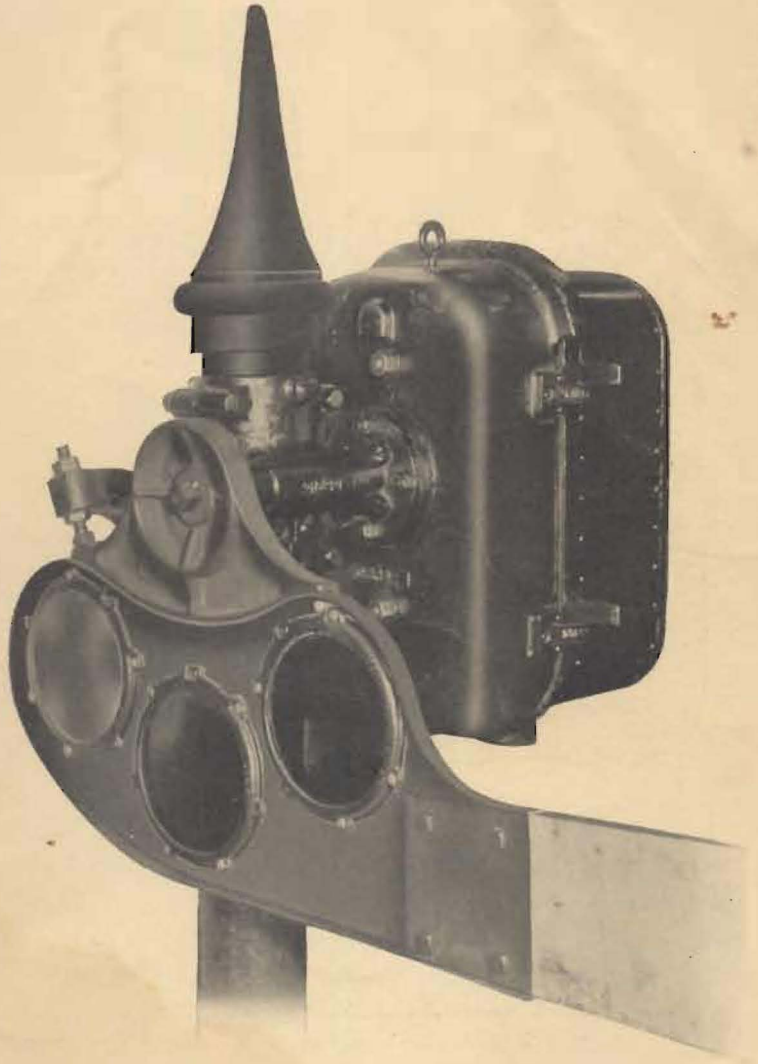

Fig. 1. Style "T-2" Signal. Front View.

Fig. 2. Style "T-2" Signal. Rear View.

THE UNION STYLE "T-2" SIGNAL

The Style "T-2" signal recently developed by The Union Switch & Signal Company is of the unit, universal type in which each semaphore arm is operated by an independent mechanism for all aspects and positions and is so designed that with slight changes either direct or alternating current can be used. The chief characteristics of this signal are the facility with which these changes can be made, the accessibility of the electrical parts and the simplicity, compactness, and strength of the design.

High and Dwarf Signals

Mechanism Case

The mechanism is mounted in a weatherproof, cast iron case, secured to the semaphore bearing, which also supports the lamp bracket and is arranged for clamping to a mast in any desired position by four bolts, Figs. 1 and 2. There are two ventilators, 35, Fig. 14, in the back of the case. Pipe conduit outlets, 49, Fig. 14, can be provided in either bottom corner. The door is hinged vertically to the case and is made of sheet iron riveted to a cast iron and aluminum frame giving lightness and strength to the structure. The door is about twice as deep as the case and when swung open as shown in Figs. 3, 11 and 12, renders every part accessible. An eye is bolted to the top of the case to facilitate hoisting into position.

Erection and Renewals

The entire mechanism may be removed from the case by unscrewing two nuts. In like manner each of the parts, such as the motor, circuit controller, etc., may be removed by unscrewing two stud bolts. This not only facilitates erection but enables subsequent changes and repairs to be made quickly.

Dwarf Signal

When used as a dwarf signal the case is equipped with a set of lugs for bolting to a foundation. With the usual type of dwarf signal spectacle it is necessary to provide springs to obtain the counterweighting effect of the high signal semaphore arm.

The Mechanism

The operating mechanism consists of an electric motor driving a train of gears, the ratio of which is 120 to 1, a circuit controller and means for holding the signal in the proceed or caution position. The motor operates the semaphore shaft through the train of gears. The gears are dropped forged steel, cut with the utmost accuracy and run on roller bearings. They are enclosed in a dust proof iron case which is secured to the mechanism case by two studs with hex nuts. This gear case may be clearly seen at 36, Fig. 6, which shows the mechanism dismembered. Oil holes have been provided, indicated by "O" in the illustrations for the gear bearings. These holes are very accessible. It will seldom be found necessary to open the gear case or remove the gears, but if for any reason this is done and the gears dismounted, care should be taken to see that they are properly meshed when put in place again. Instructions for doing this will be found pasted in each mechanism case.

Gears

Semaphore Shaft and Bearing

The semaphore shaft is connected to that of the main segmental gear by a universal joint 31, and 32, Fig. 14, which insures smooth running and provides a means of easy connection. The semaphore shaft bearing contains recesses which are used as grease cups.

Friction Clutch

In order to relieve the strain on the gears, should the motor over-travel to such an extent as to bring the segmental gear against its stop, 25, Fig. 5, 21, Fig. 13, the pinion on the motor shaft drives through a friction clutch. This clutch is adjusted to slip with a torque of from one to two foot pounds.

The Circuit Controller

The circuit controller is supported by a bracket attached by two stud bolts to the lower part of the gear case. It consists mainly

of a revolving drum, E, Fig. 13, carrying contact segment 25, moving in a space enclosed by two porcelain insulated blocks which support the contact fingers. The drum is driven by the gears through an arc three times as great as, and in the opposite direction to, that through which the semaphore arm travels. The drum has a square steel shaft, 28, on which are assembled a series of moulded insulating bushings, 26, which have square inside holes to fit the shaft and are tapered and currugated on the outside at one end to mesh with similar corrugations in the brass contact segments which are mounted on these bushings. The angular position of any segment may be changed by loosening the clamp nut 24, and disengaging it from the bushings. Adjustments as small as four degrees of the segment movement can be provided for in this way. A more minute adjustment of the contacts can then be secured by changing the position of the contact fingers 46, Fig. 14, on the supporting porcelain blocks. Each finger fits into a groove and is held in place by a screw 45, through a slotted opening. This construction, together with the large angular movement of the drum enables any circuit to be closed or opened at exactly the desired position with a wide margin of safety.

Circuit Controller Segments and Drum

Adjustment

Contact Fingers

Each contact finger is clamped in position by a short strip of phosphor bronze which covers the slot opening and is maintained in alignment by a steel stiffening spring. Contact fingers are secured to the top and bottom of the supporting block as required. The binding posts to which the connections are made are enclosed within circular openings and are readily accessible from the outside vertical face of the blocks. Each binding post is held in place by the clamp screw which secures the contact finger through the slot in the porcelain; thus the process of removing or changing a finger can be instantly performed by releasing one of these screws. This type of controller provides a sliding contact of large area between fixed contact fingers and a moving segment entirely eliminating all moving wires. The insulation between the several parts carrying current is subjected to a ground test of 5000 volts.

Binding Posts

Each controller carries eight contact segments. When all are not used, spare segments are provided in the form of complete circles

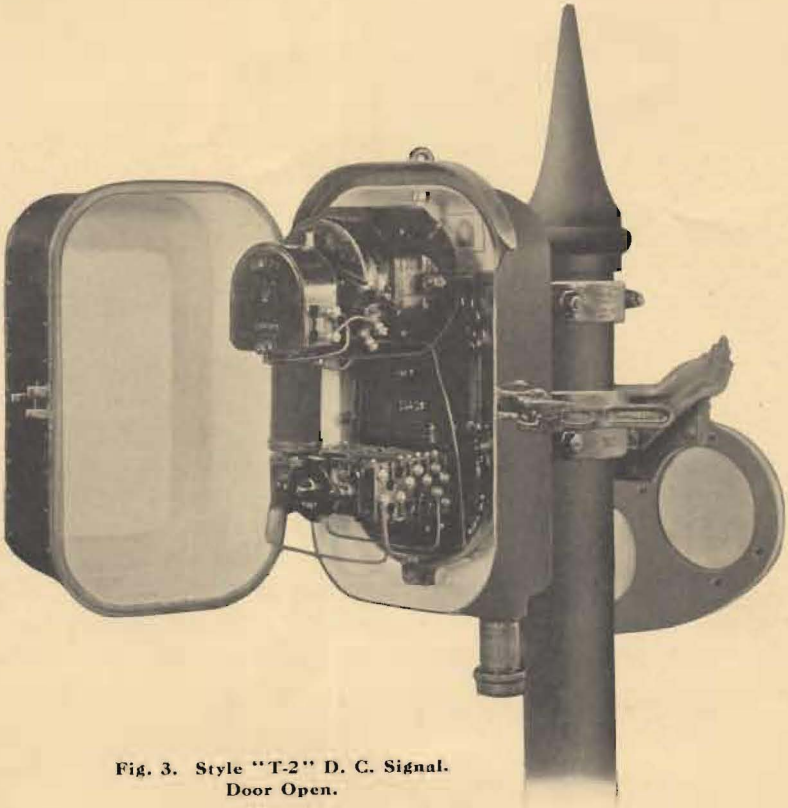

Fig. 3. Style "T-2" D. C. Signal. Door Open.

Spline Joint

and may be cut to any desired angle. For this purpose, as well as for making adjustments, the drum may be readily taken out by removing the front end bearing plates, as the drum shaft at its rear end is driven through a single spline joint, without pins or other fastenings.

D. C. Operation

This signal, for direct current operation, is provided with a direct current motor 24, Fig. 6, a holding slot and a combination of contacts in the circuit controller to suit. The holding slot controls

Control of Slot

the 45 degree motor circuit in addition to holding the semaphore arm in the caution or proceed position. As this slot can be inserted directly in a line circuit, the use of a relay at the signal solely for controlling the 45 degree motor circuit is unnecessary. The semaphore arm, when re-

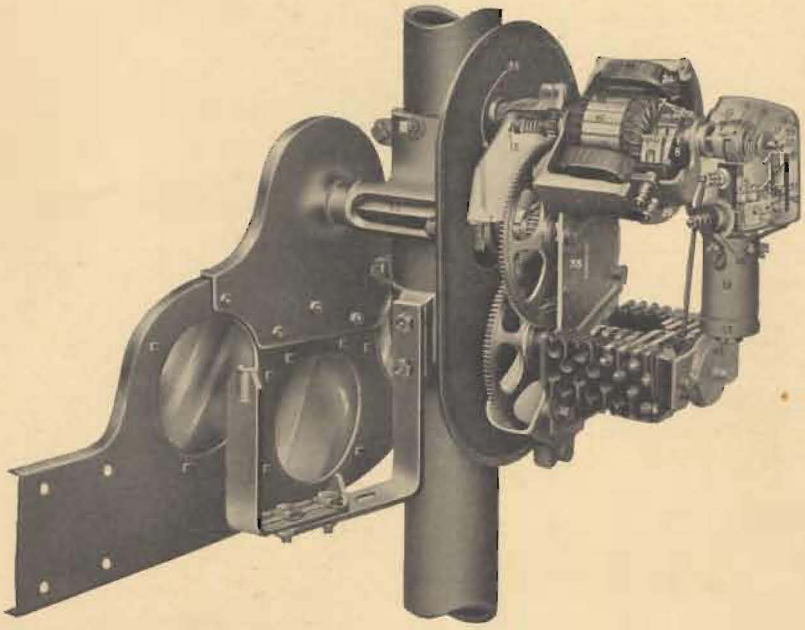

Fig. 4. Style "T-2" D. C. Signal. Parts Cut Away to Show Construction.

turning to the stop position, drives the motor backwards, so that it acts as a generator discharging current through a resistance and the frictionless dynamic braking effect thus produced is utilized instead of a dash pot in retarding the backward movement. The D. C. signal is illustrated in Figs. 3 to 7, in which the same parts have the same references.

Buffed by Dynamic Brake

The motor is of the four-pole type having lugs raised on the field casting as a means of attaching it by stud bolts to the gear case. The armature 47, is mounted on a hollow shaft 9, Fig. 7. This shaft has a ratchet connection engaging only in the direction of rotation which moves the semaphore arm toward the caution or proceed position. When therefore, the semaphore arm returns to the stop position, this ratchet frees the armature to expend the momentum thus acquired without transmitting a strain to any part of

Motor

Ratchet Drive

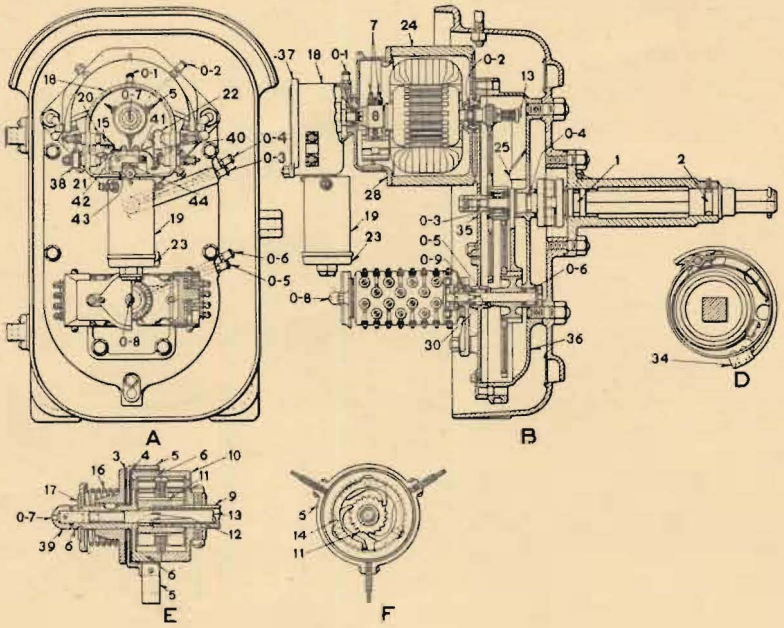

Fig. 5. Diagram of Style "T-2" D. C. Signal Mechanism and Parts.

the mechanism. The motor brushes are made accessible by the removal of a cast iron cover secured by two butterfly nuts.

The Holding Slot

Slot Magnet

The armature ratchet and the holding mechanism are placed in an aluminum case at the outer end of the motor shaft and there are, therefore, no exposed moving parts in the mechanism case except the drum of the circuit controller. The slot magnet is of the iron clad type very similar to the electro-pneumatic valve magnet in construction. The effect of energizing this magnet is to raise the arm 42, Fig. 5, pivoted to the case, which carries the steel roller 15, and the contact finger 41, closing the motor circuit at 20. This movement brings the roller into the path of the blades 5, of the stop drum, stopping its rotation, but allowing the motor to revolve by virtue of the ratchet.

Holding Mechanism

When the slot magnet is de-energized the arm 42, is released and falls back by gravity. It is also assisted in this movement by the blade of the stop drum, which tends to force the roller out of engagement and thus release the slot mechanism.

In order that there may be no undue strain brought to bear on the gears and holding mechanism when the movement of the semaphore arm toward the stop position is arrested, the stop drum and blades are not only made extremely light and thus have very little mechanical inertia, but the drum is also connected with its driving ratchet through a friction clutch. By reason of this, the signal may be easily stopped at the caution position when returning from the proceed position, or it may be stopped when the movement is almost completed and started back to the proceed position without injury to the mechanism.

Stop Drum and Ratchet Case

The armature is rigidly attached to the hollow shaft 9, to which the ratchet drum 10, is fastened by screws shown at E, Fig. 5 as mentioned above. This case carries the pawls 14, which bear against the brass sides of the case; the pins serve merely to prevent the pawls from dropping out when the ratchet is removed, lateral motion is prevented by the ring, 51, Fig. 7. The ratchet and pawls engage only when the motor is driving the gears in the process of clearing the semaphore arm. They allow the motor to run freely at the end of the stroke after being driven by the weight of the semaphore arm to the caution or stop position.

Friction Clutch on Stop Drum

Referring to E, Fig. 5, the outer end of the ratchet 11, is enclosed by a second ratchet case 6, carrying pawls which are supported in the same manner as those described above. The case 6, has a projection which serves as a bearing about the shaft 13, and to which is keyed a metal washer. This washer is free to slide longitudinally on 6, and bears against a rawhide washer 3. Against the outer face of the case is placed another rawhide washer 4, and between these washers is a stop drum 5. Spring 16 presses these parts together so as to form a friction clutch which will prevent injury to the stop blades 5, should they for any reason come into too violent contact with the roller 15. The slotted washer 17, takes the thrust of the spring 16,

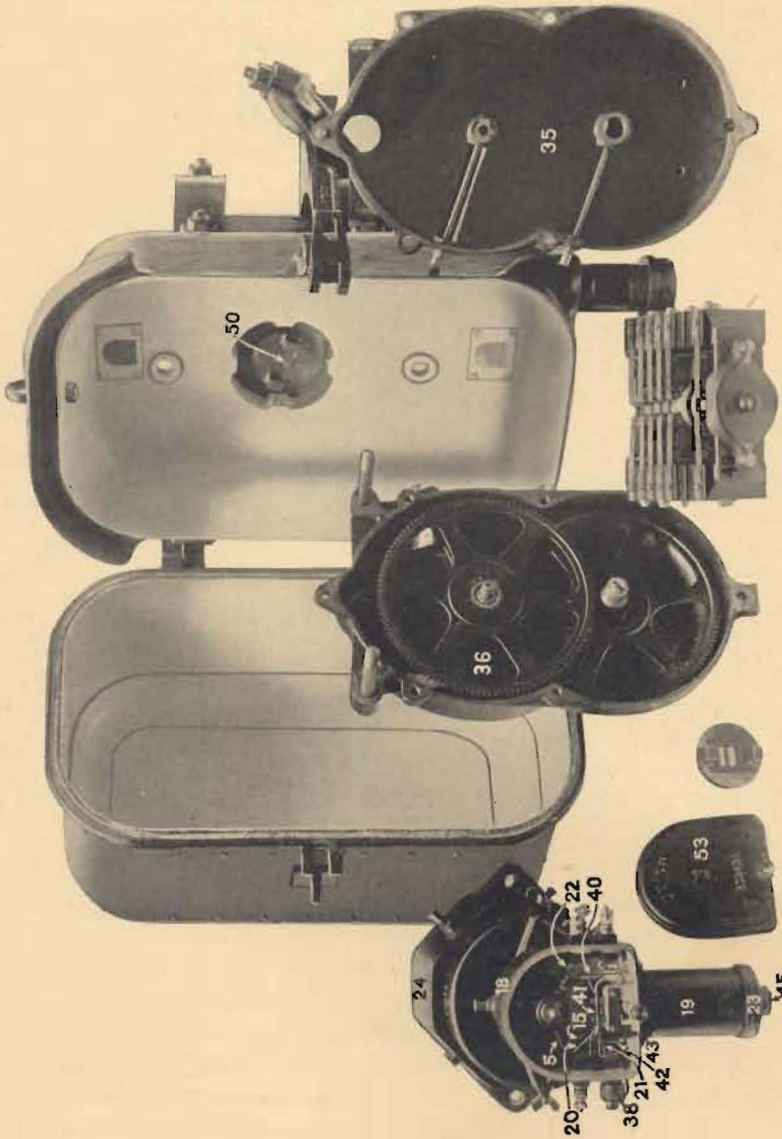

Fig. 6. Style "T-2" D. C. Signal Mechanism Dismembered.

and permits the device to be easily taken apart. When the motor is clearing the signal the ratchet does not engage with the pawls in the stop drum and consequently it does not revolve, being prevented by one of the stop blades coming in contact with the roller 15.

Adjustment of Holding Device

The motor contact 20, should be closed slightly in advance of the position in which the roller would come in contact with the ends of the stop blades in order that any blade coming directly in the path of the roller may be moved out of its way by the motor so that the signal will not be prevented from clearing. The arm 42, when the slot is de-energized closes a contact 21, which short circuits the motor through a small resistance 38, buffing the signal as mentioned above.

Change of Aspects

The holding mechanism case has raised lugs on each side drilled for the pivot of arm 42, also the insulated contact blocks are interchangeable on either side so that in changing the aspect of the signal from right hand to left, this arm can be reversed and pivoted at the opposite side; this together with the reversal of the ratchet on the pinion shaft, changing of the segmental gears, the reversal of the direction of rotation of the motor, and adjustment of the circuit controller, are the only manipulations necessary to accomplish this result. The direction of rotation of the motor may easily be changed by reversing the connections to the field coils. A removable plate below the commutator renders these connections accessible.

An explanation of the operation of the various parts in detail will be found pasted in the mechanism case of each signal under the heading "Suggestions for Maintainers."

D. C. Mechanism Wiring

Controller Segments

Fig. 8, shows the mechanism wiring for a signal to be operated by direct current at a potential not exceeding 30 volts. In this diagram contact segments of the circuit controller are represented by the circles to the right. The segments are numbered from the outer end of the controller toward the gear case, from 1 to 8. No. 8, controls the motor circuit, 7, brings the slot under the control of the 90 degree control relay when the semaphore arm is at the caution position and 1, prevents this relay from energizing until the semaphore arm has assumed the caution position.

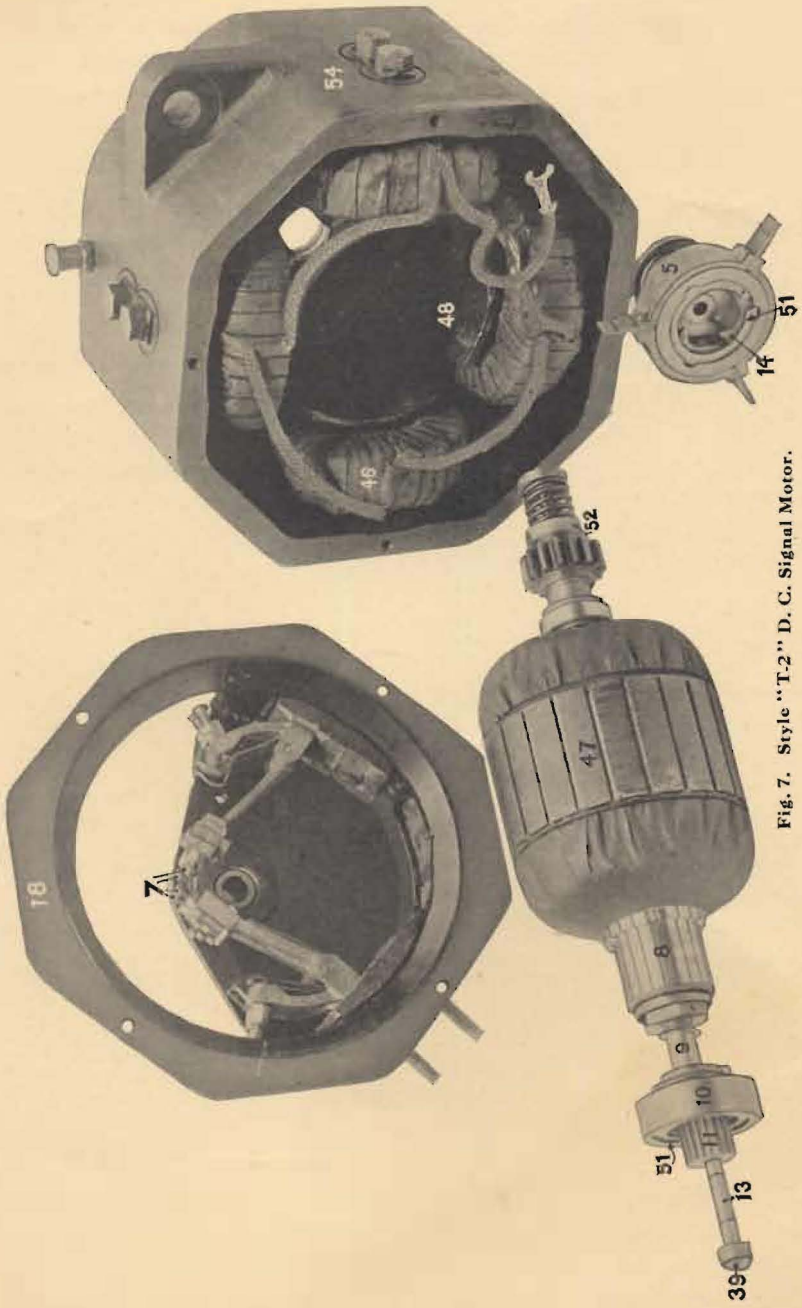

Fig. 7. Style "T-2" D. C. Signal Motor.

To move the semaphore arm from the stop to the caution position, energy is supplied to the slot magnet 19, from the 45 degree control wire A, through contact segment 7, wire B, low resistance winding of the slot coil to wire C, contact 22, wire D, through the motor and to common. The slot thus energized raises finger 41, opening contact 22, which places the high and low resistance coils in series with wire E, to common holding the slot energized and contact 20, is closed completing the motor circuit through wires D and G, and contact segment 8, to energy, wire F. When the semaphore arm reaches the caution position, segment 8, will open the circuit of the motor, but the slot, remaining energized, will retain the semaphore arm in this position.

Movement from Stop to Caution

The semaphore arm is moved to the proceed position by energizing the 90 degree control relay which requires contact segment 1 to close its contacts as previously mentioned. With this relay energized, contact segment 7, is shunted by wire H. The slot magnet however, still receives its energy from the 45 degree control wire A. Another point on the relay closes the motor circuit through wire I, and the lower contacts on segment 8. This segment, as before, opens the motor circuit when the semaphore arm has reached the proceed position and 7, opens on the first movement of the semaphore arm toward this position. Adding the jumpers P, and Q, has the effect of shunting out the 90 degree control relay. They are used for two-position operation from 0 degrees to 90 degrees.

Movement from Caution to Proceed

De-energizing the control circuits will cause the slot magnet to release. The back point of finger 41, will then make contact at 21, thus closing the "buffing circuit" on the motor through wire D, finger 41, resistance 38, and wire E, to slow up the movement of the semaphore arm as it approaches the stop position as previously described. If the 90 degree control relay only is de-energized the slot will be released until contact segment 7, closes the circuit at the caution position when it will hold on the 45 degree control circuit.

Return to Stop Position

The circuit shown in Fig. 9, differs from that just described in

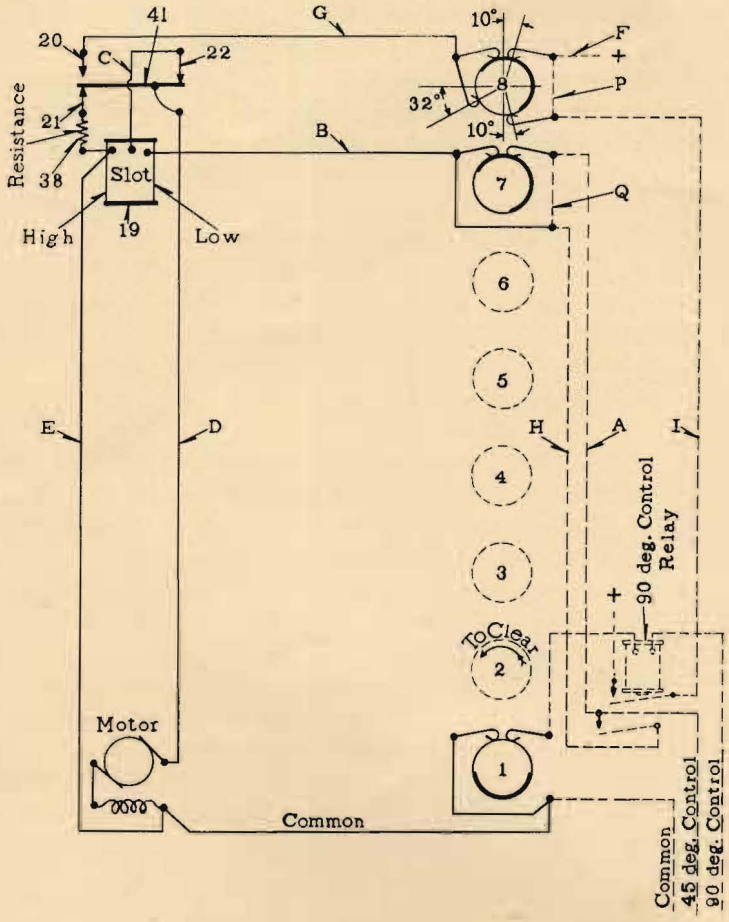

Fig. 8. Mechanism Wiring. Low Voltage Style "T-2" D. C. Signal.

Circuit Without 90 Degree Control Relay

that there is no 90 degree control relay, as is the case when polarized track circuits are used. In this circuit the control wires also carry the current for operating the motor. The 45 degree control circuit energizes the slot magnet in a manner similar to that shown in Fig. 8. The jumpers J, and K, are provided to carry current for the motor between segments 7, and 8, the circuit of which is otherwise the same as that previously described.

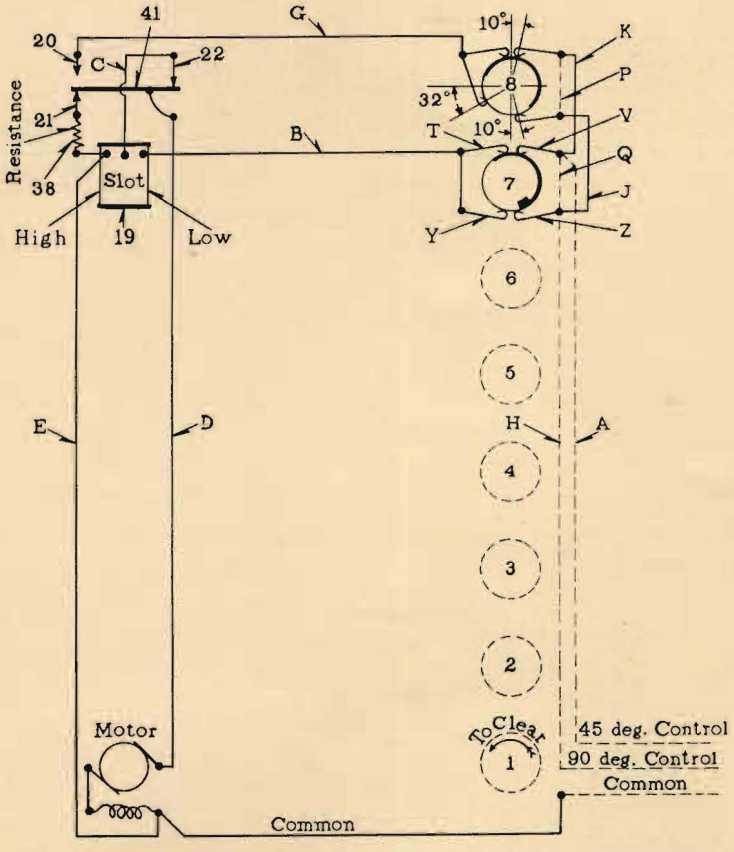

Fig. 9. Mechanism Wiring. Low Voltage Style " T-2" D. C. Signal with Snap Circuit Controller Segment.

The segment 7, transfers the slot circuit from the 45 degree to the 90 degree control wire when the blade begins to move toward the proceed position. For this purpose the bottom set of fingers Y, and Z, are provided. A peculiarity of this segment is that the contacts Y, and Z, close before contacts T, and V, open when the signal is clearing, but when the movement is from the proceed to the caution position this condition is reversed; that is, contacts Y, and Z, open before contacts T, and V, close. This prevents the motor from

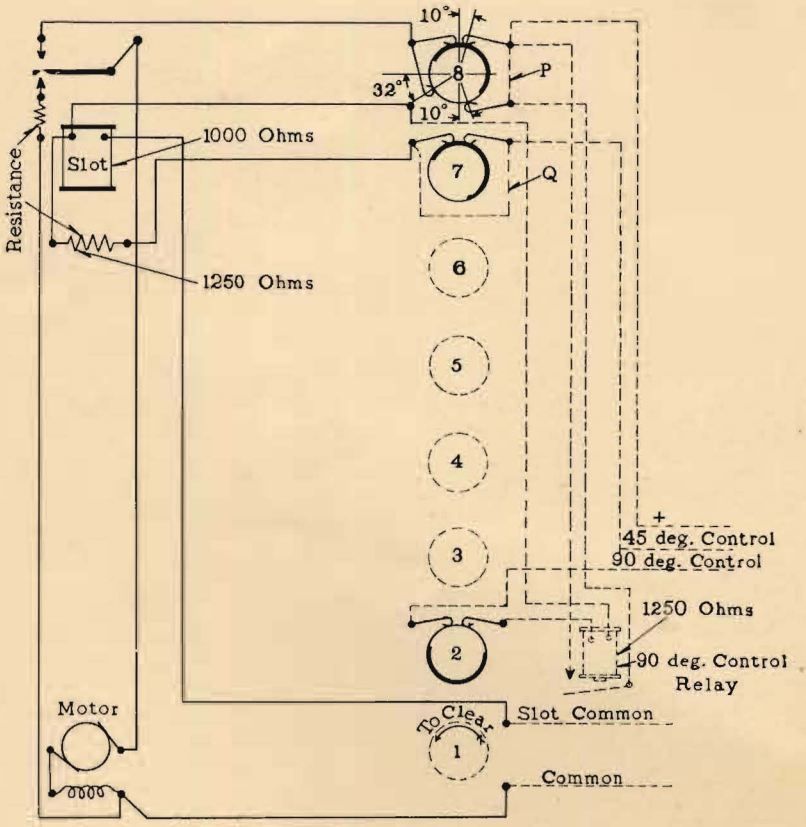

Fig. 10. Mechanism Wiring. High Voltage Style "T-2" D. C. Signal.

being energized through wire J, which would cause the signal to pump. To secure this result a snap segment 34, D, Fig. 5, is provided which, when the semaphore arm is being moved to the stop position, has the same movement as the controller shaft, but when moved in the opposite direction is so held by friction with the contact fingers that it moves through a smaller arc than the shaft until the pressure of the fingers is released with the semaphore arm in the caution position. In this position the slot magnet is energized by the 45 degree control circuit. It will be noted that the 90 degree control circuit first operates the motor causing segment 7, to close contacts Y, and Z, and open contacts T, and V. The purpose of the jumpers P, and Q, has been described in connection with Fig. 8.

Snap Segment

The circuit shown in Fig 10, is used where the operating potential exceeds 30 volts. In this case there is ample energy for picking up the slot magnet without the use of a low resistance winding, hence contact 22, shown in the other circuits, is omitted. The operation of this circuit will be apparent from the description of Fig. 8. Here there is a slight modification however, in that the 90 degree control relay is connected in series with the slot magnet and a coil equal in resistance to that of this relay is used in the 45 degree control circuit. Other modifications may be introduced to meet any special conditions. The winding of the motor must, of course, be suited to the voltage of the circuit.

High Voltage Circuit

When used with polarized track or line circuits, two contact segments of the circuit controller are arranged to act as a pole changer for reversing the polarity of the track or line circuit. The quick movement of the controller, together with the inertia of the signal mechanism and the fact that the motor can pick up at any point of the stroke renders a snap pole changer for this purpose unnecessary. Indication locks for interlocking signals may be controlled by one of the controller segments cut for the purpose. In each mechanism case will be found a wiring diagram showing how the mechanism is connected up.

Pole Changer

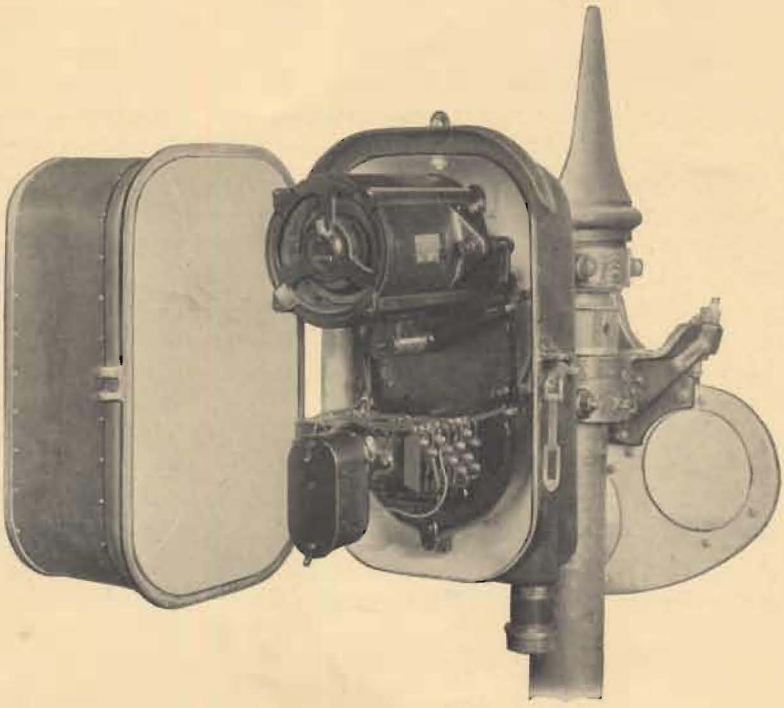

Fig. 11. Style " T-2 " A. C. Signal. Door Open.

A. C. Operation

This signal is fitted for A. C. operation by the use of an A. C. motor, holding slot and an arrangement of circuit controllers to suit. It differs from the D. C. arrangement in that the slot is in the form of a rotor and stator so that all latches or other mechanical holding devices are eliminated. This arrangement of the signal is shown in Figs. 11, to 15, in all of which the same parts have the same references.

Motor and Slot

The motor and slot 37, Fig. 14, are enclosed within the same casing 60, Fig. 15, and secured to the gear case by the same stud bolts as in the case of the D. C. motor. The motor is of the induction

Fig. 12. Style "T-2" A. C. Signal. Door Open.

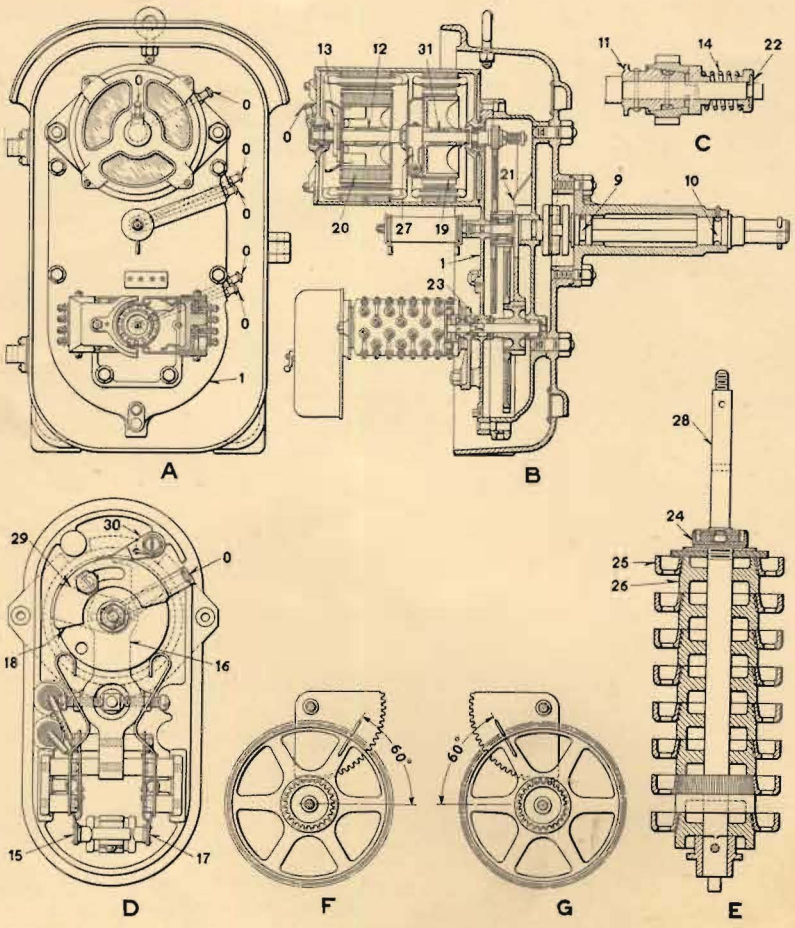

Fig. 13. Diagram of Style "T-2" A. C. Signal Mechanism and Parts.

Squirrel Cage Rotors

type with standard squirrel cage rotor 20, and laminated stator 40, made of transformer steel. The bars and end plates of the rotor are securely riveted and well soldered together. The construction of the slot is very similar to that of the motor except that it is not so wide and contains only eight poles. The slot rotor 19, is mounted loosely on the pinion shaft to which it has a flexible connection by means of an arm fixed on this shaft engaging the rotor through a helical spring. There is a single winding on the slot stator 39, which produces a flux between the adjacent pole pieces. The rotor bars tend to take up a position outside of this field which is the middle of the stator poles and by inductive reaction will resist any effort to drive them into this field. Thus the slot holds the mechanism in the caution or proceed position. The flexible connection of the rotor absorbs the vibration of the semaphore arm when brought to a stop by the slot without disturbing the magnetic relations between the rotor and stator.

Flexible Slot Connection

Method of Holding

The motor rotor is also loosely mounted upon the pinion shaft which it engages through a ratchet 13, when driving the semaphore arm towards the caution or proceed position, but it is freed from the shaft on the backward stroke after the semaphore arm comes to stop the same as in the case of the D. C. motor. This ratchet is visible through a celluloid plate 42, in the front end of the motor case and is protected by a metal shield 43, as is also the flexible connection of the slot rotor by a shield 44. These shields are provided to guard against the possibility of broken parts getting into the air gap and interfering with the free movement of the rotor.

Driving Ratchet

In changing the aspect of the signal to one requiring the shaft to move in the opposite direction, it is only necessary to change the connections to the motor and its driving ratchet to cause its rotation in the opposite direction, change the main segmental gear and adjust the circuit controller. The slot has equal holding effect in either direction.

Change of Aspect

A. C. Mechanism Wiring

The mechanism wiring shown in Fig. 16, is for single phase operation and intended for use with a three-position relay. Contact

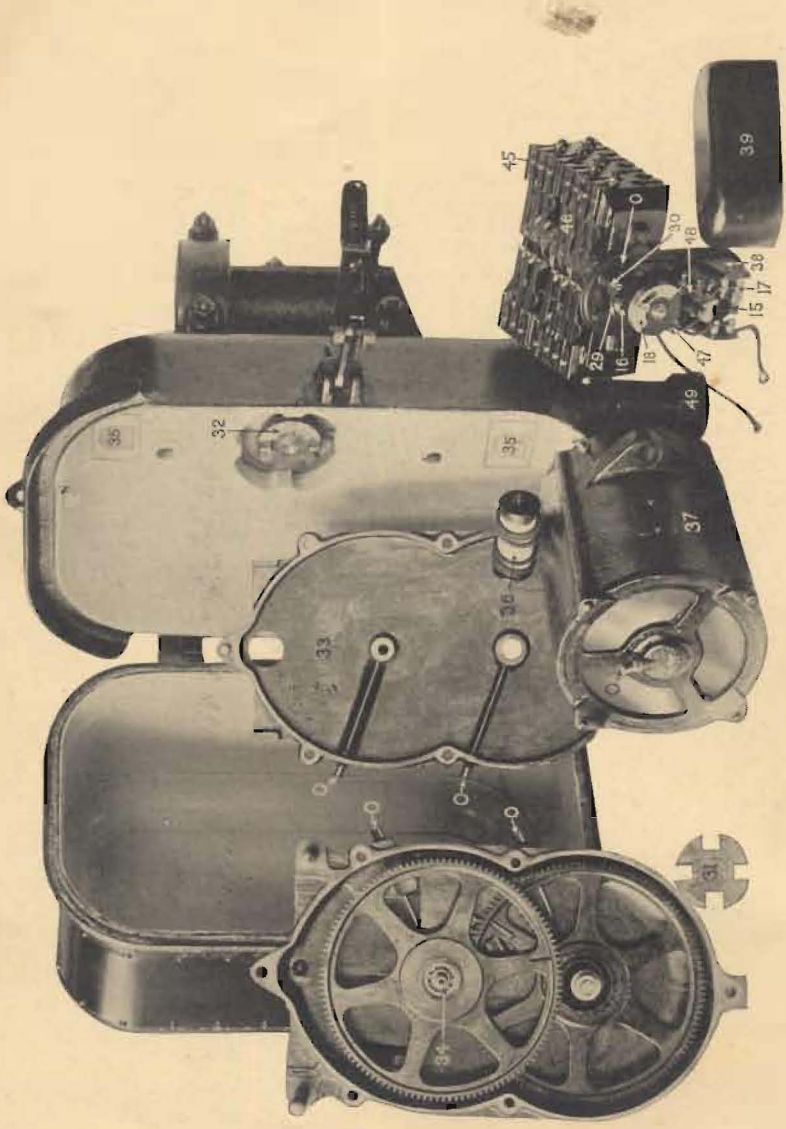

Fig 14. Style "T-2" A. C. Signal Mechanism Dismembered.

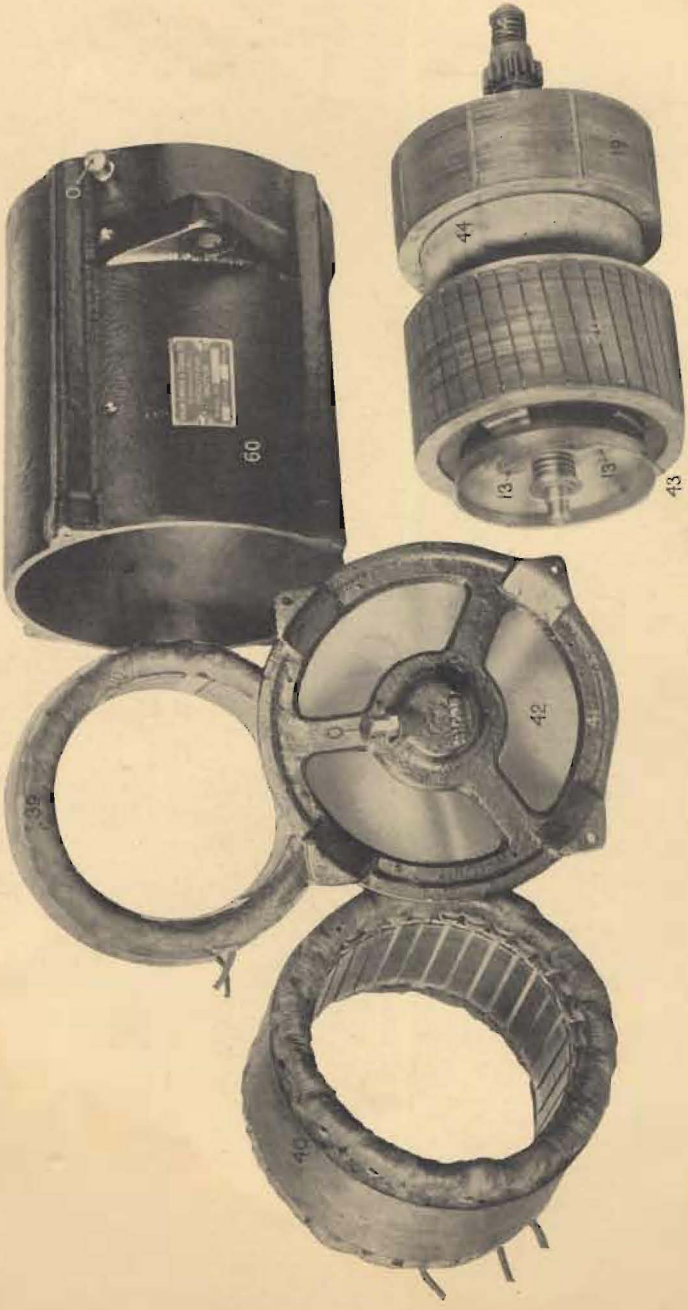

Fig. 15. Style "T-2" A. C. Signal Motor.

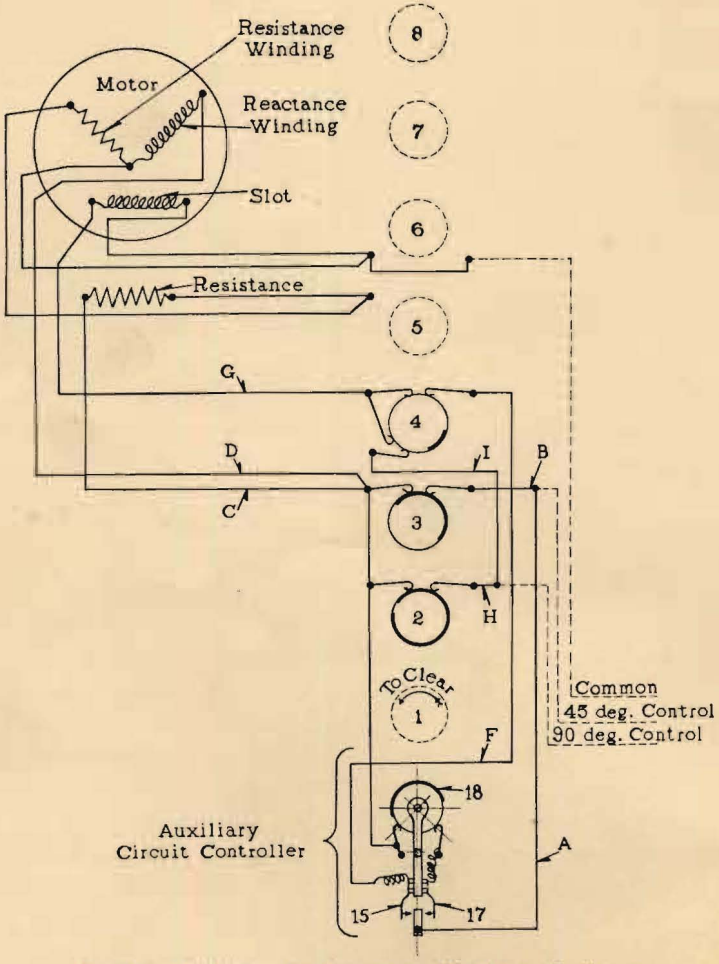

Fig. 16. Mechanism Wiring. Style "T-2" A. C. Signal.

segment 2, controls the motor circuit for the proceed position and segment 3, controls the circuit for the caution position. Segment 4, controls the slot circuit. When used for three position signals an auxiliary circuit controller attached to the end of the regular circuit controller shaft is used to produce a retarding torque through the motor when the semaphore arm is returning from the proceed to the caution position and thus assist in bringing the rotor of the slot to a stop so as to enable it to hold. This controller, D, Fig. 13, consists of a contact segment 18, and a vertical arm 16, which carry two movable contact fingers 15, and 17, at the lower end. This arm has a limited horizontal motion between two stop screws which enables the circuit to be closed at 15, in one direction, and at 17, in the other direction. By a friction drive contact 15, is held closed when the semaphore arm is being moved toward the proceed position and it is also held closed if the semaphore arm returns to the stop position before reaching a position corresponding to 81 degrees movement from stop. Beyond this position the arm 29, raises pawl 30, releasing the vertical arm to close contact 17, when the motion of the semaphore arm is reversed.

Single Phase Operation

Auxiliary Circuit Controller

When energy is supplied to the 45 degree control wire it passes to the motor through contact segment 3, and wires C, and D. The circuit of wire C, includes a resistance coil 36, Fig. 14, secured to the gear case under the motor. This is used to produce a phase displacement between the currents in the two windings of the motor stator to bring about the effect of a rotating magnetic field usual in motors of this kind. The motor winding connected with this coil is known as the resistance winding. The winding of the motor connected to wire D, is known as the reactance winding. The windings connected to wires C, and D, make connection to common.

Movement from Stop to Caution

The holding circuit in the caution position is through wire A, contact 15, wire F, contact segment 4, and wire G, through the slot winding to common. When the 90 degree control circuit is energized the motor circuit is completed through wire H, and contact segment 2, in the manner described above. The holding circuit in the proceed position is through wire I, contact segment 4, and wire G, to the slot coil.

Holding Circuit

Movement from Caution to Proceed

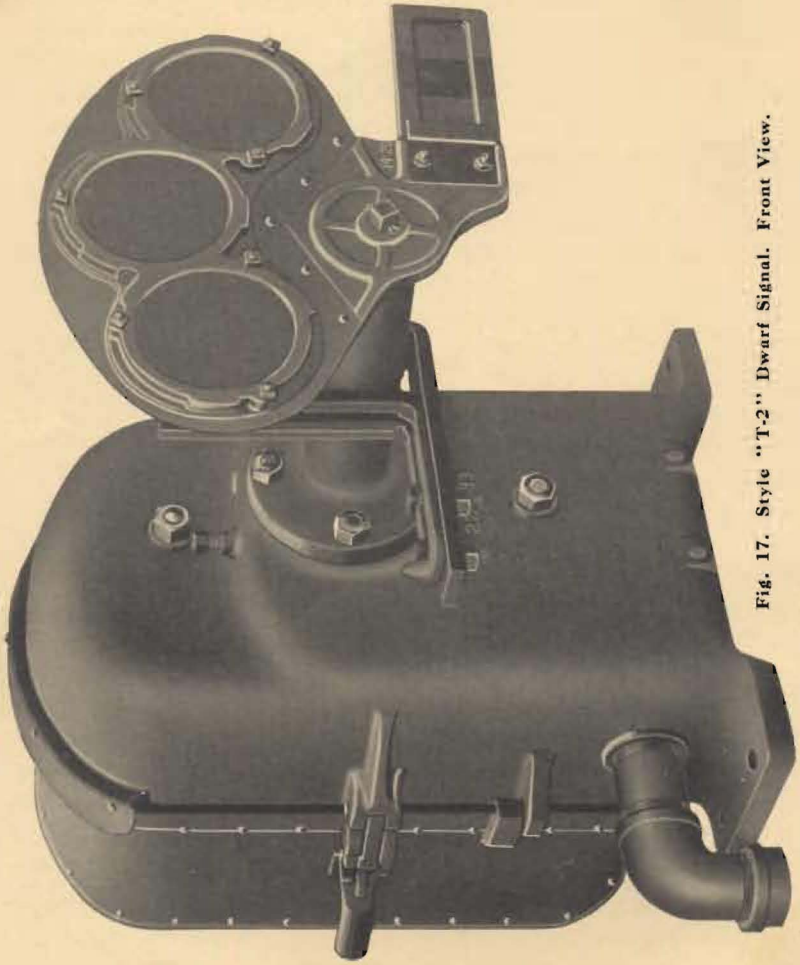

Fig. 17. Style "T-2" Dwarf Signal. Front View.

Polyphase Signal

When polyphase current is used, the resistance referred to for phase splitting with single phase current is unnecessary. The motor, of course, must be suited to the characteristics of the current and the frequency.

When the semaphore arm is returning from the proceed to the caution position the auxiliary circuit controller is brought into play. In this case contact 15, is opened and contact 17, is closed and the circuit to the motor from the 45 degree control wire is completed through the contact fingers bearing against contact segment 18, these fingers are shown at 47, and 48, Fig. 14. Segment 18, has an adjustment between the positions corresponding to 42 degrees and 52 degrees of the stroke of the semaphore arm and is arranged to close the circuit of the motor when the caution position is reached in a manner tending to produce rotation in a direction to move the semaphore arm towards the proceed position again. This has the effect of stopping the mechanism and the first movement of the mechanism tending to drive the semaphore arm towards the proceed position opens the motor circuit at 17, and closes the slot circuit from the 45 degree wire at 15, thus enabling the slot to hold in this position.

Return from Proceed to Caution

The mechanism wiring for a two position signal is somewhat simpler, contact segments being necessary only to open the motor circuit and close the slot circuit. No auxiliary circuit controller for buffing is needed for the two position signal because naturally, the return movement of the semaphore arm does not have to be slowed up so that the slot may hold at caution; the rotating parts do not accumulate sufficient momentum to cause jarring at the stop position. In each mechanism case will be found detailed instructions for the care of the signal entitled "Suggestions for Maintainers" together with a wiring diagram.

Two Position Signal

This signal is not only universal in its aspects and indications, but is also universal in its applicability to interlocking and block signal work and can be controlled from either line or local energy with a proper arrangement of circuits. The application of a D. C. signal to automatic block signaling is shown in Fig. 19, and that of an A. C. signal in Fig. 20; Fig. 21 shows a D. C. signal connected up for non-automatic operation at an interlocking plant. The various apparatus and circuits involved are named in these illustrations and will be readily understood.

Typical Circuits

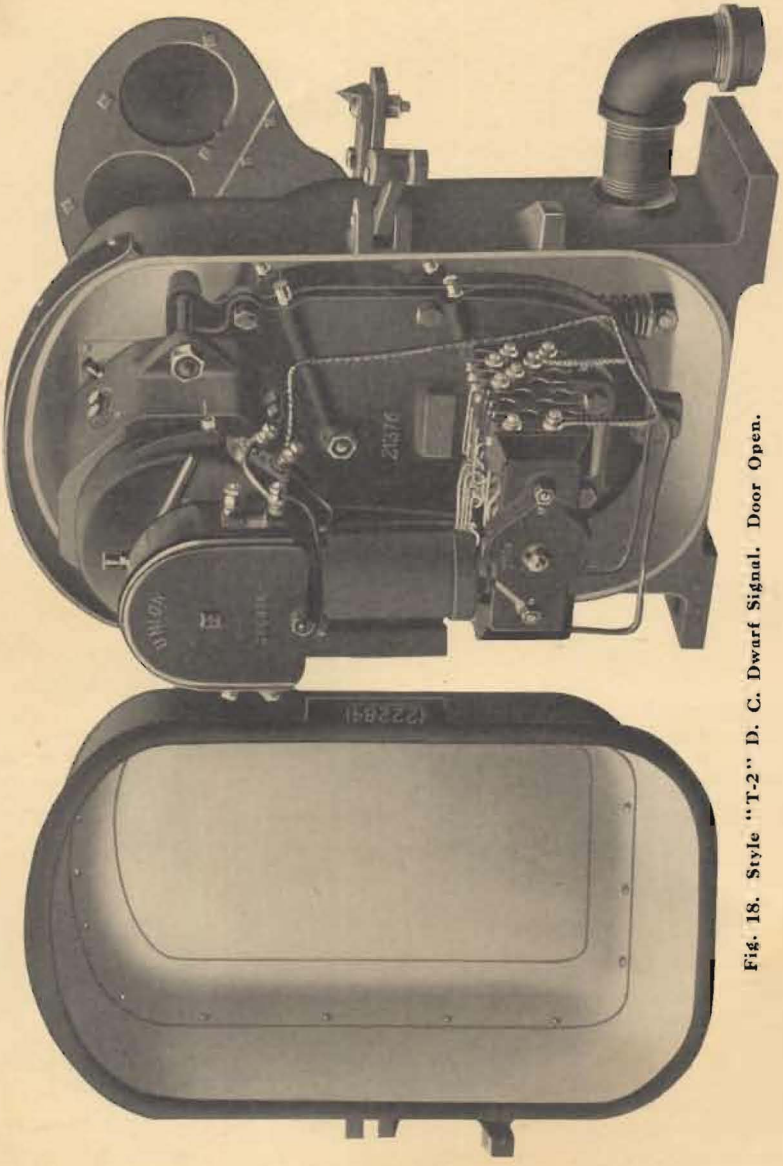

Fig. 18. Style "T-2" D. C. Dwarf Signal. Door Open.

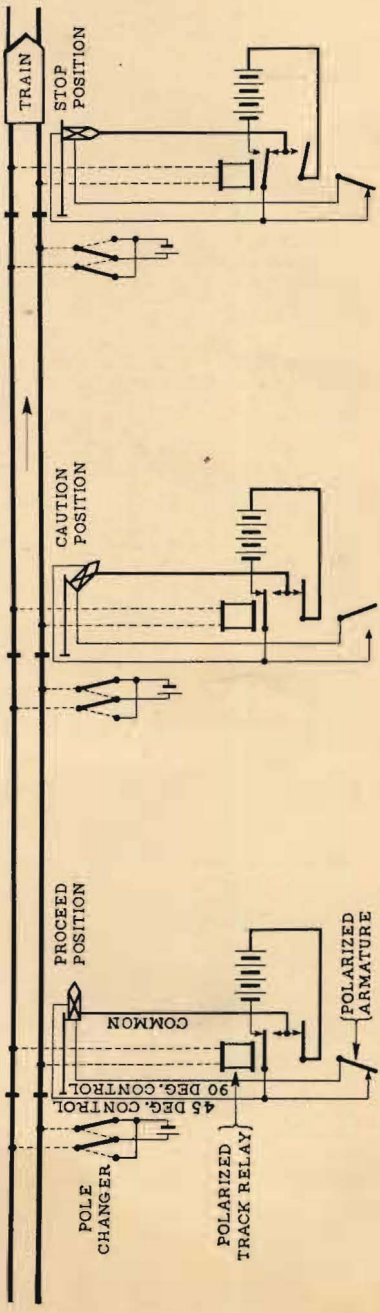

Fig. 19. Typical Circuits for Style "T-2" D. C. Signals Used in Automatic Block Signaling.

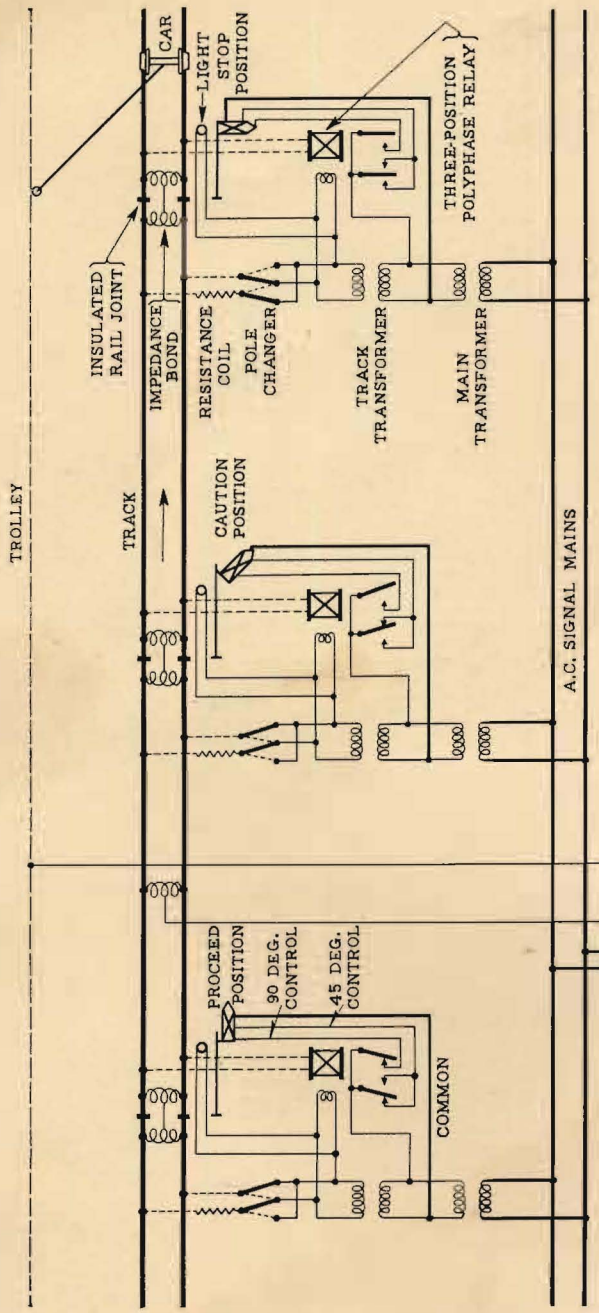

Fig. 20. Typical Circuits for Style "T-2" A. C. Signals Used in Automatic Block Signaling.

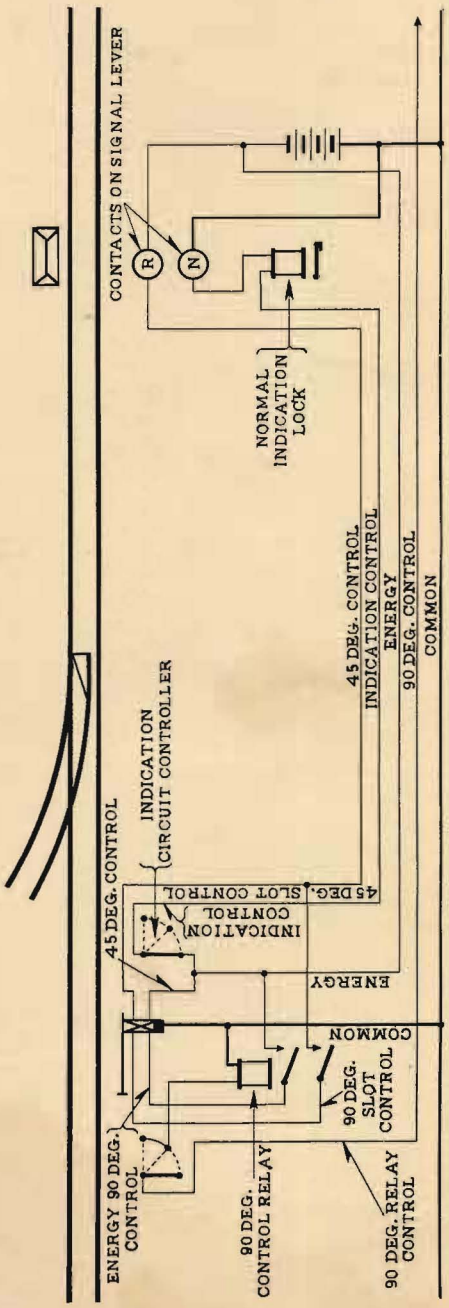

Fig. 21. Typical Circuits for Style "T-2" D. C. Signal Controlled by a Lever in an Interlocking Plant.

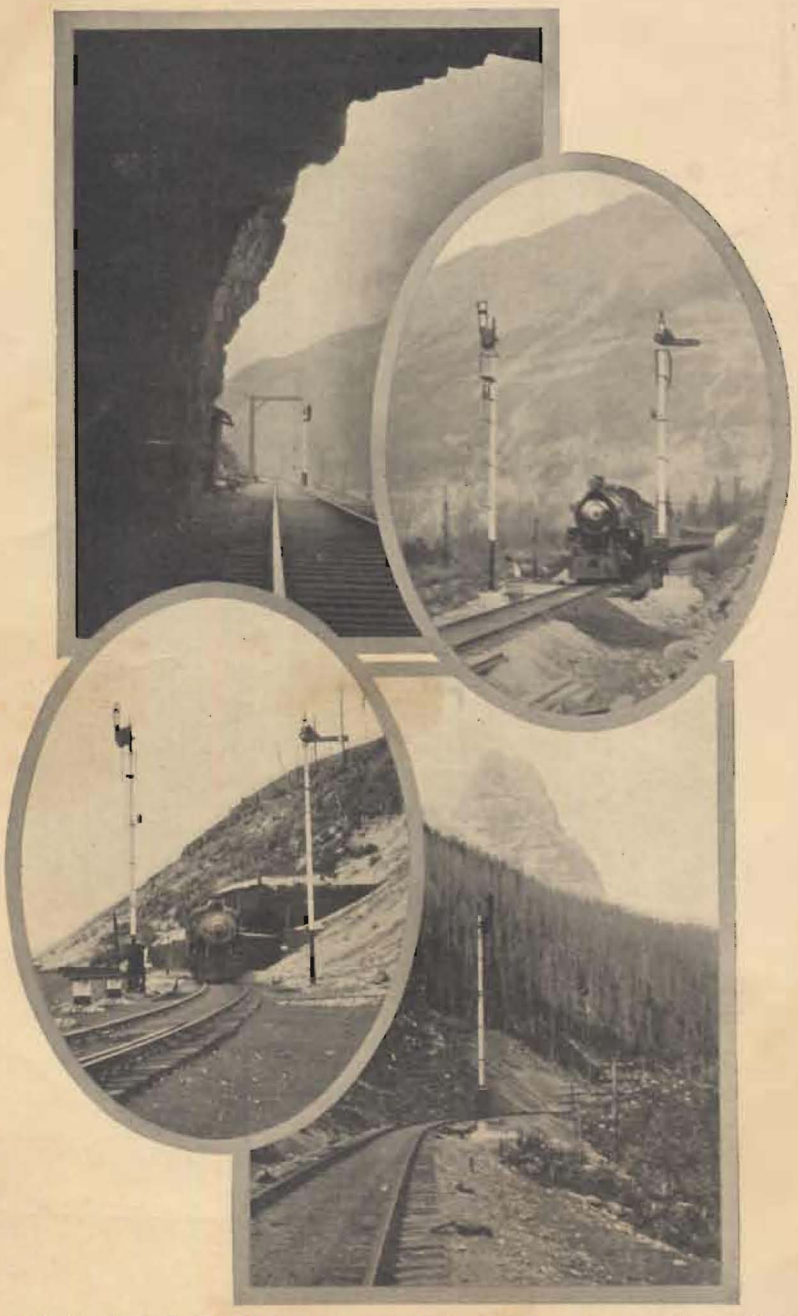

Fig. 22. Style "T-2" D. C. Automatic Block Signals on the Canadian Pacific.